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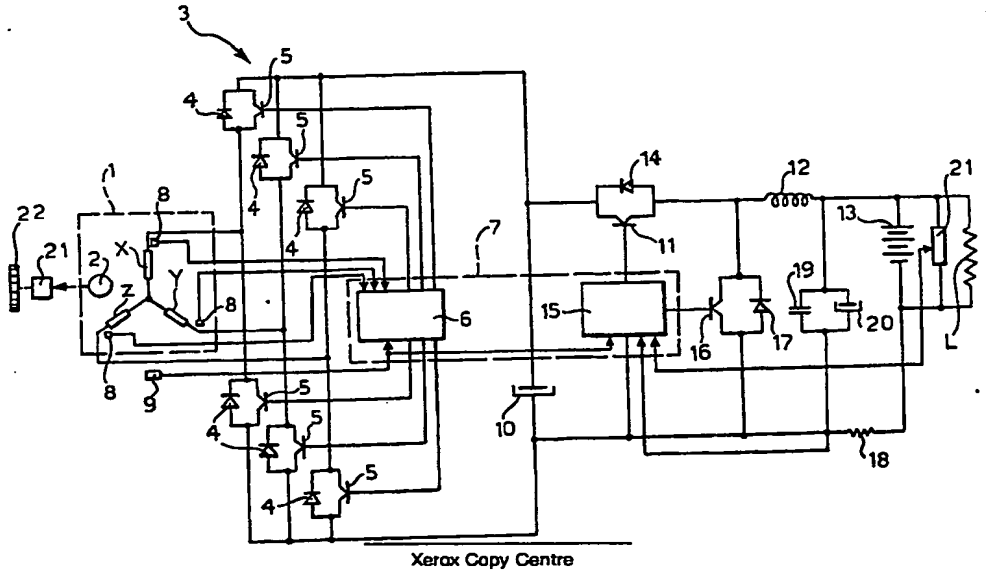
(54) An electric generator-motor system, particularly for use as a generator and starter motor in a motor vehicle.

(57) The system includes:
- a rechargeable direct-current voltage supply (13),
- a rotary electrical machine (1,2) with a polyphase armature (X,Y,Z),
- a controlled polyphase bridge circuit (3-6) adapted to act as a rectifier (4) when the electrical machine (1,2) is operating as a generator and as an inverter (5,6) when the electrical machine (1,2) is operating as a motor, and
- voltage-reducing devices (11,12,15,19,20) for reducing the voltage between the bridge circuit (3-6) and the supply (13) when the electrical machine (1,2) is operating as a generator.



EP 0 406 182 A1

AN ELECTRIC GENERATOR-MOTOR SYSTEM, PARTICULARLY FOR USE AS A GENERATOR AND STARTER MOTOR IN A MOTOR VEHICLE

The present invention relates to an electric generator-motor system, particularly for use as a generator and a starter motor in a motor vehicle provided with an internal combustion engine.

The system according to the invention is characterised in that it comprises in combination

- a rechargeable direct-current voltage supply,
- a rotary electrical machine with a polyphase armature,
- polyphase control means interposed between the electrical machine and the supply and adapted to act as rectifier means when the electrical machine is operating as a generator for supplying a rectified output current to the supply and/or a load, and as inverter means for providing the armature of the electrical machine with a polyphase current supply when the electrical machine is operating as a motor supplied with energy from the supply, and
- voltage-reducing means for reducing the voltage between the control means and the supply to a value suitable for recharging the supply when the electrical machine is operating as a generator.

Preferably, the rotary electrical machine is of the synchronous type and includes field-generator means with permanent-magnets.

The system may conveniently also include voltage-boosting means for increasing the voltage between the supply and the control means when the electrical machine is operating as a motor.

According to a further characteristic, the control means include a controlled polyphase bridge circuit piloted by an electronic control and operating unit.

Six rectifier diodes are provided in the bridge circuit, which is preferably of the three-phase type, and a respective controlled switching device, such as a transistor, is arranged in parallel with each diode.

Further characteristics and advantages of the present invention will become clear from the detailed description which follows with reference to the appended drawing which is provided by way of non-limiting example and shows the electrical layout of a system according to the invention.

With reference to the drawing, an electric generator-motor system according to the invention includes a rotary electrical machine, generally indicated 1, which is preferably of the synchronous type and has a three-phase armature whose windings are indicated X, Y and Z. These windings are connected in a star arrangement in the embodiment illustrated and are carried by a conventional stator, not shown.

The synchronous electrical machine 1 also includes a rotor 2 carrying field-generator means, preferably constituted by permanent magnets.

A three-phase bridge circuit, generally indicated 3, is connected to the armature windings of the machine 1. The circuit includes six rectifier diodes 4 each connected in parallel with the collector-emitter path of a respective transistor 5. The bases of the transistors are connected in order to corresponding inputs of a piloting circuit 6 which forms part of an electronic control and operating unit, generally indicated 7.

Sensors 8 are also connected to the piloting circuit 6 and are associated in order with the windings X, Y and Z so as to provide electrical signals indicative of the currents flowing in these windings. The sensors may be constituted, for example, by Hall-effect devices.

A speed sensor 9 is also connected to the piloting circuit 6 and provides electrical signals indicative of the angular velocity of the rotor of the electrical machine 1.

A capacitor 10 is connected in parallel with the bridge circuit 3.

A transistor, indicated 11, has its collector-emitter path arranged between the bridge circuit 3 and one terminal of an inductor 12 the other terminal of which is connected to the positive pole of a rechargeable direct-current voltage supply 13. This supply is constituted, for example, by the normal battery of a motor vehicle.

A diode 14 is connected in parallel with the collector-emitter path of the transistor 11 and has its cathode connected to the bridge circuit 3 and its anode connected to the inductor 12.

The base of the transistor 11 is connected to an output of an operating circuit 15 included in the electronic control and operating unit 7.

A further transistor, indicated 16, has its collector-emitter path connected between the junction between the diode 14 and the inductor 12 and earth. The base of this transistor is also connected to an output of the operating circuit 15 of the electronic unit 7.

A diode 17 is connected in parallel with the collector-emitter path of the transistor 16, with its cathode on the side nearest the inductor 12.

A resistor, indicated L in the drawing, represents a generic load connected to the supply 13.

A shunt resistor, indicated 18, is connected in series with the battery 13 and the load L. This resistor is also connected to an input of the operating circuit 15 and is intended to act as a sensor for sensing the current supplied to the battery 13 and the load L by the motor-generator system in operation.

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The present invention relates to an electric generator-motor system, particularly for use as a generator and a starter motor in a motor vehicle provided with an internal combustion engine.

The system according to the invention is characterised in that it comprises in combination

- a rechargeable direct-current voltage supply,
- a rotary electrical machine with a polyphase armature,
- polyphase control means interposed between the electrical machine and the supply and adapted to act as rectifier means when the electrical machine is operating as a generator for supplying a rectified output current to the supply and/or a load, and as inverter means for providing the armature of the electrical machine with a polyphase current supply when the electrical machine is operating as a motor supplied with energy from the supply, and
- voltage-reducing means for reducing the voltage between the control means and the supply to a value suitable for recharging the supply when the electrical machine is operating as a generator.

Preferably, the rotary electrical machine is of the synchronous type and includes field-generator means with permanent-magnets.

The system may conveniently also include voltage-boosting means for increasing the voltage between the supply and the control means when the electrical machine is operating as a motor.

According to a further characteristic, the control means include a controlled polyphase bridge circuit piloted by an electronic control and operating unit.

Six rectifier diodes are provided in the bridge circuit, which is preferably of the three-phase type, and a respective controlled switching device, such as a transistor, is arranged in parallel with each diode.

Further characteristics and advantages of the present invention will become clear from the detailed description which follows with reference to the appended drawing which is provided by way of non-limiting example and shows the electrical layout of a system according to the invention.

With reference to the drawing, an electric generator-motor system according to the invention includes a rotary electrical machine, generally indicated 1, which is preferably of the synchronous type and has a three-phase armature whose windings are indicated X, Y and Z. These windings are connected in a star arrangement in the embodiment illustrated and are carried by a conventional stator, not shown.

The synchronous electrical machine 1 also includes a rotor 2 carrying field-generator means, preferably constituted by permanent magnets.

A three-phase bridge circuit, generally indicated 3, is connected to the armature windings of the machine 1. The circuit includes six rectifier diodes 4 each connected in parallel with the collector-emitter path of a respective transistor 5. The bases of the transistors are connected in order to corresponding inputs of a piloting circuit 6 which forms part of an electronic control and operating unit, generally indicated 7.

Sensors 8 are also connected to the piloting circuit 6 and are associated in order with the windings X, Y and Z so as to provide electrical signals indicative of the currents flowing in these windings. The sensors may be constituted, for example, by Hall-effect devices.

A speed sensor 9 is also connected to the piloting circuit 6 and provides electrical signals indicative of the angular velocity of the rotor of the electrical machine 1.

A capacitor 10 is connected in parallel with the bridge circuit 3.

A transistor, indicated 11, has its collector-emitter path arranged between the bridge circuit 3 and one terminal of an inductor 12 the other terminal of which is connected to the positive pole of a rechargeable direct-current voltage supply 13. This supply is constituted, for example, by the normal battery of a motor vehicle.

A diode 14 is connected in parallel with the collector-emitter path of the transistor 11 and has its cathode connected to the bridge circuit 3 and its anode connected to the inductor 12.

The base of the transistor 11 is connected to an output of an operating circuit 15 included in the electronic control and operating unit 7.

A further transistor, indicated 16, has its collector-emitter path connected between the junction between the diode 14 and the inductor 12 and earth. The base of this transistor is also connected to an output of the operating circuit 15 of the electronic unit 7.

A diode 17 is connected in parallel with the collector-emitter path of the transistor 16, with its cathode on the side nearest the inductor 12.

A resistor, indicated L in the drawing, represents a generic load connected to the supply 13.

A shunt resistor, indicated 18, is connected in series with the battery 13 and the load L. This resistor is also connected to an input of the operating circuit 15 and is intended to act as a sensor for sensing the current supplied to the battery 13 and the load L by the motor-generator system in operation.

2), the sensor means being connected to the electronic control unit (7) which is arranged to pilot the polyphase bridge circuit (3) in a predetermined manner in dependence on the signals supplied by the sensor means (8).

9. A system according to Claim 8, characterised in that the control means also include sensor means (9) for sensing the speed of rotation of the rotor (2) of the electrical machine (1, 2), the sensor means being connected to the electronic control and operating unit (7) which is also arranged to pilot the polyphase bridge circuit (3) in a predetermined manner in dependence on the signals supplied by the speed sensor means (9).

10. A system according to any one of Claims 5 to 7, characterised in that the voltage-reducing means comprise a first controlled switch (11) piloted by modulated-width pulses (PWM) from an electronic control and operating unit (15, 7), the first controlled switch (11) being arranged in series between the output of the bridge circuit (3) and the supply (13) and any load (L).

11. A system according to Claim 10, characterised in that an LC-type integrating and filtering circuit (12, 19, 20) is interposed between the first controlled switching device (11) and the supply (13) and any load (L).

12. A system according to Claim 11, characterised in that the integrating and filtering circuit comprises an inductor (12) connected in series with the first controlled switch (11) and a first capacitor (19, 20) in parallel with the supply (13) and with any load (L).

13. A system according to any one of Claims 10 to 12, characterised in that a second capacitor (10) is connected in parallel with the output of the bridge circuit (3).

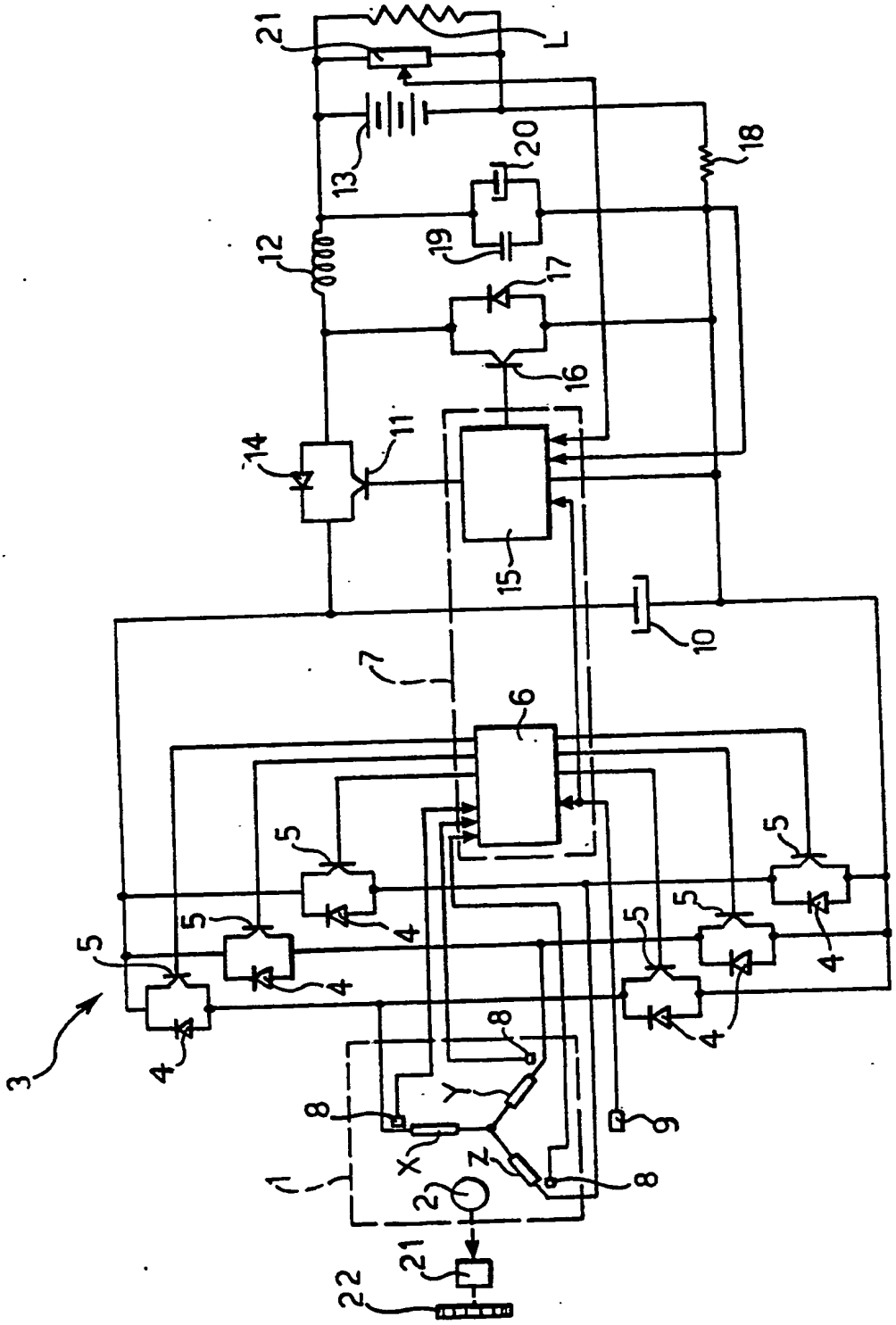
14. A system according to any one of Claims 5 to 12, characterised in that the voltage-boosting means comprise:

- a capacitor (10) connected in parallel with the bridge circuit (3),
- an inductor (12) in the path of the current between the supply (13) and the capacitor (10),
- a second controlled switch (16) arranged in parallel with the capacitor (10); the second controlled switch (16) being piloted in an on/off manner by the electronic control and operating unit (7, 15) when the electrical machine (1, 2) is acting as a motor so that, when the second switch (16) is conductive (on), energy is stored in the inductor (12) and is then discharged into the capacitor (10) when the second controlled switch (16) is non-conductive (off).

15. A system according to Claims 13 and 14, characterised in that a single capacitor (10) is connected in parallel with the polyphase bridge circuit (3) and acts as a voltage smoother when the electrical machine (1, 2) is acting as a generator and as a voltage booster when the electrical machine (1, 2) is acting as a motor.

16. A system according to any one of the preceding claims, characterised in that it also includes sensor means (21) for sensing the voltage in any load (L).

17. A system according to any one of the preceding claims, characterised in that, in order to operate as the starter motor of an internal combustion engine, the rotor (2) of the electrical machine (1, 2) is coupled for rotation with a member (22) of an internal combustion engine by means of a differential reduction unit (21).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EUROPEAN SEARCH REPORT

Application Number

EP 90 83 0291

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0260176 (VALEO) * page 4, lines 6 - 11 * * page 8, line 31 - page 9, line 26; figures 12-14. *	1, 3-12, 17.	F02N11/04
A	WO-A-8703648 (ROBERT BOSCH) * page 2, lines 17 - 30 *	2.	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 46 (M-360)(1769) 27 February 1985, & JP-A-59 185872 (NISSAN JIDOSHA K.K.) 22 October 1984, * the whole document *		
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 179 (E-414)(2235) 24 June 1986, & JP-A-61 26500 (HITACHI LTD.) 05 February 1986, * the whole document *		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F02N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 SEPTEMBER 1990	BIJN E.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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